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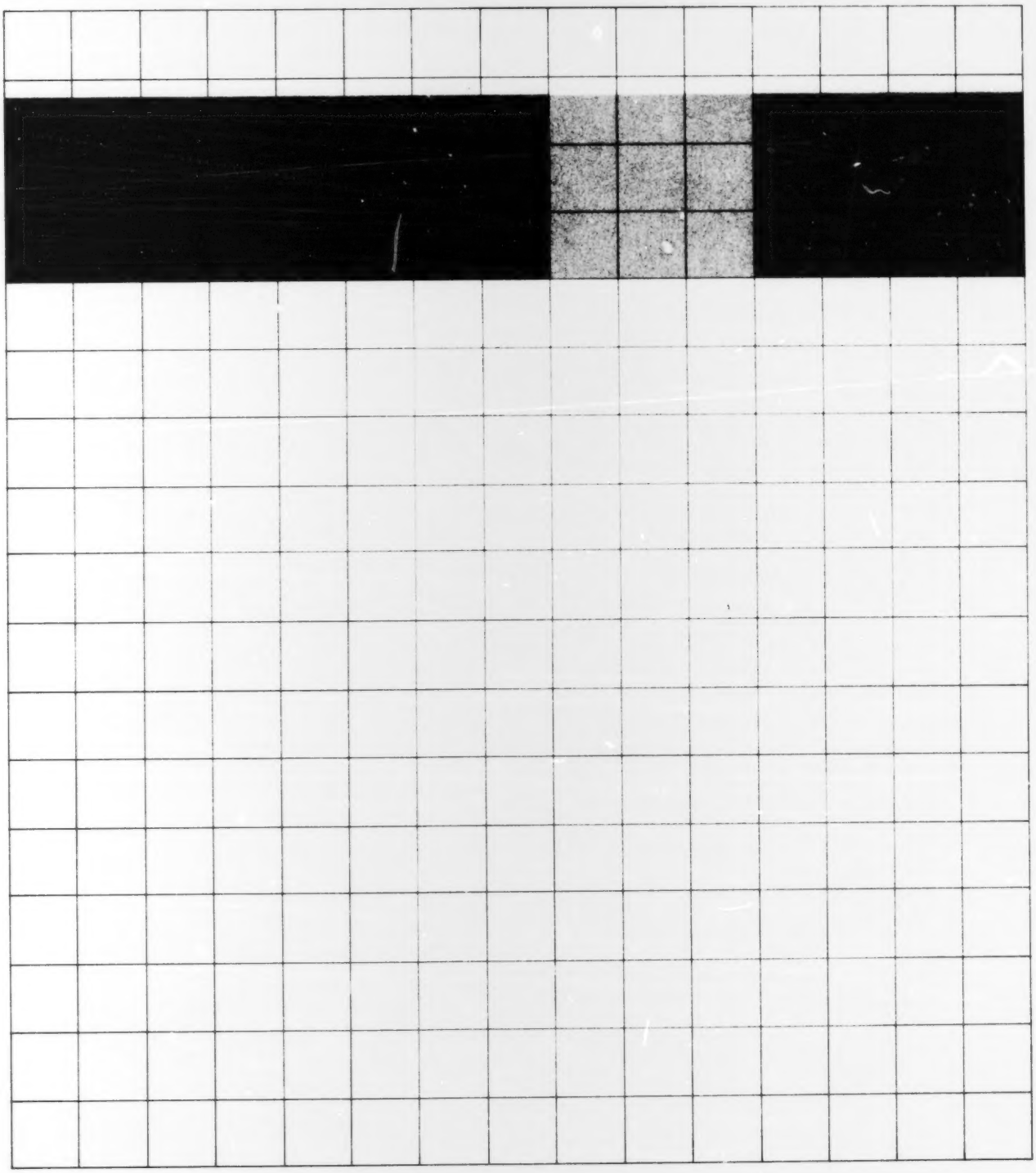
Assigning Grid Coordinates and Traffic Zones to Postal Codes



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Assigning Grid Coordinates and Traffic Zones to Postal Codes

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Contents

1/ Introduction 1

2/ Canadian Postal Code System 2
2.1/ Canadian Postal Code 2
2.2/ Postal Code Directory 2
2.3/ Postal Code Map 3

3/ The Geographically Referenced Data Storage and Retrieval System 6
3.1/ Universal Transverse Mercator System 6
3.2/ Area Master File 6
3.3/ Geocoding at the Block-Face Level 7
3.4/ Geocoding at the Census Enumeration Area Level 7

4/ Methodology for Assigning Geocodes to Postal Codes 8
4.1/ Assigning Geocodes to Postal Codes in Urban Areas 8
4.1.1/ Urban Areas with Area Master Files 8
4.1.1.1/ Block-Face Method 8
4.1.1.2/ Digitizing Method 9
4.1.2/ Urban Areas Without Area Master Files 10
4.2/ Assigning Geocodes to Postal Codes in Rural Areas 11
4.3/ Areas on The UTM Zone Boundaries 11

5/ Postal Code-Geocode Files for Areas in Southern Ontario 12
5.1/ Postal Code-Geocode File for Metropolitan Toronto 12
5.2/ Postal Code-Geocode File for Oshawa 13
5.3/ Postal Code-Geocode Files for Brampton, Mississauga, Oakville, Woodbridge, Thornhill, Richmond Hill and Pickering 13
5.4/ Postal Code-Geocode Files for Markham, Ajax, Whitby and Newmarket 13

6/ Methodology for Converting Postal Codes to Traffic Zones 14
6.1/ Geocode Method 14
6.1.1/ Assumptions 14
6.1.2/ Definitions 14
6.1.3/ Modification of the Postal Code-Geocode File 14
6.1.4/ Digitizing Zone Centroids and Nodes 16
6.1.5/ Traffic Zone Boundary File 16
6.1.6/ Computer Program Creating Postal Code-Traffic Zone Conversion File. 16
6.2/ Assigning Traffic Zones to Postal Codes in Rural Areas 17

7/ Postal Code-TARMS Traffic Zone Conversion File For Metropolitan Toronto 19

8/ Testing of Methodology for Converting Postal Codes to TARMS Traffic Zones 20
8.1/ Matching Results for the 1980 Metropolitan Toronto Employee Travel Survey 20
8.2/ Matching Results for the 1975 City Toronto Employee Travel Survey 20

9/ Costs and Savings of Postal Code-Geocode-Traffic Zone Conversion File 22

10/ Potential uses of the Postal Code-Geocode-Traffic Zone Conversion File 22

11/ Expanding the Postal Code-Geocode-Traffic Zone Conversion System to Other Urban Areas in Ontario 23

12/ References 23

Appendix A: Area Master Files for Areas in Canada (1981) 24

List of Tables

1/ Postal Code Directories on Magnetic Tapes 4
2/ Allocation of Forward Sortation Areas 4
3/ Area Master File (Statistics Canada) 9
4/ Postal Code Directory (Canada Post) 9
5/ Postal Code-Geocode File (MTC) 10
6/ Urban Areas in Ontario 11
7/ Postal Code-Geocode Files for Areas in Southern Ontario 12
8/ Postal Code-Geocode File for Metropolitan Toronto, Summary of Matching Results 12
9/ Postal Code-Geocode File for Oshawa, Summary of Matching Results 13
10/ Postal Code-Geocode-TARMS Traffic Zone File for Scarborough 18
11/ Assigning TARMS Traffic Zones to the 1980 Metropolitan Toronto Employee Travel Survey 21
12/ Assigning TARMS Traffic Zones to the 1975 City of Toronto Employee Travel Survey 21

List of Figures

1/ Toronto Metropolitan Postal District-Forward Sortation Areas 3
2/ Local Delivery Unit Map 5
3/ Universal Transverse Mercator Zones for Ontario 6
4/ The Area Master File (Special Format) 7
5/ Space Gaps, Overlaps, and Embedments 14
6/ Traffic Zones with Curved Boundaries 15
7/ Traffic Zones with Straight Line Boundaries 15
8/ Nodes, Centroid, Boundary Lines, X and Y Ranges of Traffic Zone 15
9/ Intersecting and Non-Intersecting Lines 15
10/ Intersecting Points 17
11/ Matching Results for the 1980 Metropolitan Toronto Employee Travel Survey 19
12/ Matching Results for the 1975 City of Toronto Employee Travel Survey 19

Summary

Manual coding of grid coordinates for home addresses was found to be one of the most time consuming elements in running the Ministry's carpool matching program. Transportation planners face similar problems in converting home addresses to traffic zones for transportation analysis. The elimination of this manual process will save time and money.

In June, 1979 the Transport and Vehicle Systems Research and Development Office of the Ministry of Transportation and Communications initiated an investigation into computer methods of converting street addresses to geocodes and traffic zones. Methodologies were developed to create a postal code-geocode-traffic zone conversion file.

The Canadian postal code offers a unique reference system for urban areas, which in many applications provides a more convenient means of identifying a place than the street address, and requires less computer storage. Postal code directories on magnetic tape are available from Canada Post.

In the Geographically Referenced Data Storage and Retrieval System, Statistics Canada created Area Master Files for urban areas where geocoding has been completed at the block-face level. A block-face is defined as one side of a city street between consecutive intersections with other streets. Unique identifying coordinate numbers are assigned to each block-face. *The coordinate system chosen is known as the Universal Transverse Mercator System.*

There are a number of similarities between the Postal Code Directory and the Area Master File. For urban areas with Area Master Files, two methods are used to assign geocodes to postal codes creating postal code-geocode files. The Block-Face Method matches street names and address number ranges in the Postal Code Directory with those in the Area Master File, and links postal codes and geocodes. The Digitizing Method digitizes postal codes manually for areas where street names and address number ranges are not in the Area Master File.

The creation of new Area Master Files and the use of the Block-Face method is recommended as the preferred approach for urban areas without Area Master Files. Statistics Canada is prepared to provide assistance in creating Area Master Files for any urban areas.

Postal code-geocode files for Metropolitan Toronto and surrounding areas were created. For Metropolitan Toronto and Oshawa, 94% of the postal codes were automatically assigned with geocodes by computer. For surrounding areas in the Toronto region, the automatic assignment ranged from 55% to 85%. This lower rate was mainly due to new addresses not in the 1971 Area Master Files used. Statistics Canada plans to update its Area Master Files semi-annually. The percentage of codes which can be assigned automatically is expected to increase as a result of the updates.

The 1980 Postal Code Directory showed an increase of 432 (1%) postal codes for Metropolitan Toronto and of 3667 (21%) for surrounding areas, when compared with the 1979 Directory.

Traffic zone boundaries and postal code-geocode files can be used to create conversion files to assign traffic zones to postal codes. A postal code-traffic zone conversion file has been created for Metropolitan Toronto. All but 26 of the 43 844 postal codes were located within the given boundaries. In a test of the Scarborough area, 26 (0.3%) of 8158 codes were found to be assigned to the wrong zones.

Comparisons were made between two methods of assigning traffic zone numbers to Toronto Employee Travel Survey data. The geocode method was to use the postal code-geocode conversion file to convert postal codes to zone numbers. The second method made use of census tracts to go from the postal code to the traffic zone. The Metropolitan Toronto Planning Department has created a file to convert census tracts to traffic zones where the boundaries coincide. Manual assignment is used where they do not. The geocode method was able to match 98% of the records having valid Metro postal codes automatically, compared with 92% by combined automatic and manual methods using census tracts. It is concluded that the geocode method for assigning zone numbers to survey data is likely to be more accurate and reliable than the census tract method or any other manual coding procedure. There is also a significant saving both in time and cost using the postal code-traffic zone conversion file.

In rural areas, the postal code indicates a specific post office, not the rural address. Rural routes often cover several traffic zones. It is concluded that the present postal code system for rural areas may not be suitable for geographical and transportation referencing. More investigation is required.

The postal code-geocode-traffic zone conversion file has many applications besides carpooling and transportation planning studies. Expanding the present conversion file to other urban areas in the Province is recommended. The use of postal codes in any geographic data coding will provide added flexibility for future analysis.

Bi-yearly update of the conversion file for Metropolitan Toronto and yearly update for surrounding areas is recommended.

1 / Introduction

In 1978, the Ministry of Transportation and Communications (MTC) initiated a pilot carpool demonstration project. Manual coding of grid coordinates for home addresses was found to be one of the most time consuming elements in running the Ministry's carpool matching program. Similar problems exist in transportation planning in that home addresses have to be converted manually to traffic zones in order to create an origin/destination matrix. A data file that assigns grid coordinates and traffic zones to Canadian Postal Codes would eliminate the manual coding process.

The purpose of this study is to examine the Canadian Postal Code System, geocoding systems, and traffic zone systems in order to set up methodologies for assigning grid coordinates and traffic zones to any postal code in Metropolitan Toronto and surrounding areas. The data files thus created may have many applications other than for carpooling and transportation planning, both by the Ministry of Transportation and Communications and by other Government Agencies.

2/ Canadian Postal Code System

2.1/ Canadian Postal Code

The Canadian Postal Code is a permanent part of the postal address. It is composed of six alphanumeric characters, in the form of ANA NAN, where 'A' represents a letter of the alphabet, and 'N' a number. There is a space separating the first three characters, the Forward Sortation Area (FSA), from the last three, the Local Delivery Unit (LDU).

In urban areas, the FSA describes an area roughly the size of 25 letter carrier routes [1]. The LDU denotes a very small and easily defined section within the area described by the FSA. It can specify a city block (one side of a city street between consecutive intersections with other streets), an apartment building, an office building or a large firm or organization which does considerable business with the post office. It can also denote a service from a post office or postal station. These services include post office boxes (as used by many businesses), rural routes and general delivery.

In small towns and villages without nome delivery, the postal code indicates a specific post office. In rural areas the post office service area and rural routes may cover several traffic zones and cross one or more municipal boundaries.

2.2/ Postal Code Directory

Canada Post provides its postal code directories in two forms.

1. Hard copy postal code directories are available free of charge. These directories are updated and reprinted annually [1].
2. Postal code directories on magnetic tapes can be obtained by contacting the local Marketing Department [2]. There is a labour and computer time charge for copying the tapes. On average, these tapes are updated bi-weekly.

Table 1 shows the postal code directories on magnetic tape available in eighteen sections for the whole of Canada, and the 1979 cost schedule.

2.3/ Postal Code Map

Two types of maps are used to describe postal areas and to identify city blocks and apartment buildings. They are:

1. Forward Sortation Area Map
2. Local Delivery Unit Map

Forward Sortation Area maps outline the urban and rural areas covered by the Forward Sortation Areas. Table 2 gives a summary of the allocation of Forward Sortation Areas in Canada. As of 1980, 392 urban Forward Sortation Areas and 56 rural Forward Sortation Areas had been allocated in Ontario [3]. Figure 1 depicts the Forward Sortation Area map covering the Metropolitan Toronto postal district.

Figure 1/ Toronto Metropolitan Postal District— Forward Sortation Areas

Table 1/ Postal Code Directories on Magnetic Tapes

Magnetic Tapes Available

The entire country is available in eighteen sections as follows:

	Section	Cost*
1.	Newfoundland (including Labrador)	$30.00
2.	Prince Edward Island	30.00
3.	Nova Scotia	32.00
4.	New Brunswick	30.00
5.	Quebec Province East (east of a line from Fort Rupert to Trois-Rivières to Lac Mégantic)	44.00
6.	Quebec Province West (west of a line from Fort Rupert to Trois-Rivières to Lac Mégantic)	40.00
7.	Montreal (Metropolitan)	71.00
8.	Ontario East (east of a line from Port Hope to Lindsay and south of a line from Lindsay to Pembroke)	39.00
9.	Ontario Central (area enclosed by lines drawn from Port Hope to Lindsay to Parry Sound to Hamilton - includes Niagara Peninsula and excludes Toronto)	51.00
10.	Ontario West (west of a line from Hamilton to Parry Sound to the U.S. border)	53.00
11.	Ontario North (all the province north of the Lindsay-Pembroke line)	34.00
12.	Toronto (Metropolitan)	67.00
13.	Manitoba	33.00
14.	Saskatchewan	32.00
15.	Alberta	33.00
16.	British Columbia	50.00
17.	Yukon	30.00
18.	Northwest Territories	30.00
	NATIONAL	$729.00

*1979 Cost Schedule

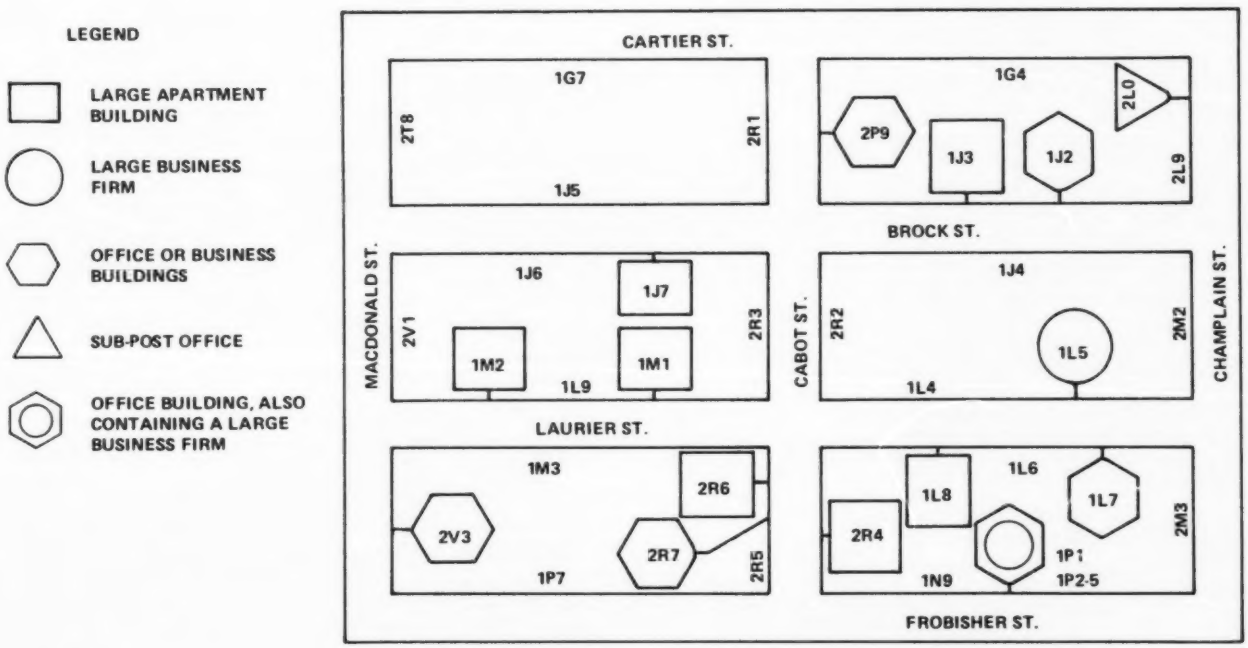
Table 2/ Allocation of Forward Sortation Areas

Major Geographic Areas	FSA's in Use			FSA's in Reserve		
	Urban	Rural	Total	Urban	Rural	Total
A Newfoundland	11	13	24	169	7	176
B Nova Scotia	34	15	49	146	5	151
C Prince Edward Island	5	2	7	175	18	193
E New Brunswick	21	9	30	159	11	170
*G Quebec East	77	20	97	103	nil	103
H Montreal Metro	121	2	123	59	18	77
J Quebec West	92	20	112	88	nil	88
K Eastern Ontario	61	10	71	119	10	129
L Central Ontario	108	14	122	72	6	78
M Toronto Metro	101	nil	101	79	20	99
N Southwestern Ontario	98	13	111	82	7	89
P Northern Ontario	24	19	43	156	1	157
R Manitoba	42	10	52	138	10	148
S Saskatchewan	24	11	35	156	9	165
*T Alberta	81	10	91	99	10	109
V British Columbia	146	18	164	34	2	36
X Northwest Territories	1	5	6	179	15	194
Y Yukon	1	2	3	179	18	197
	1048	193	1241	2192	167	2359

*AMENDED 1 February 1980

Local Delivery Unit maps are street maps with the last three characters of the postal code identified on the sides of the city blocks. The exact locations of apartment buildings, business firms and sub-post offices are marked. Local Delivery Units are assigned by regional post offices. In general, there is no regular pattern for the allocation. Figure 2 depicts a Local Delivery Unit map.

It can be difficult to obtain the Local Delivery Unit maps from Canada Post. The maps are copyrighted and there is usually only one copy which is being continually updated.



BREAKDOWN OF A TYPICAL CITY AREA, SHOWING HOW THE LAST THREE CHARACTERS OF THE POSTAL CODE ARE ALLOCATED

Figure 2/ Local Delivery Unit Map

3/ The Geographically Referenced Data Storage and Retrieval System

In July 1966, Statistics Canada initiated an investigation into computer methods for geographic coding, storage and retrieval of census data. After five years' research, a fully computerized Geographically Referenced Data Storage and Retrieval (GRDSR) System was developed [4]. Through GRDSR, statistical information for areas that range in size from a few city blocks to an entire urban area can be quickly obtained.

The basic concept behind the GRDSR system is that of assigning unique coordinates to the building blocks. Geographic base files with the descriptions of the building blocks and their identifying coordinates are created. These identifying coordinates are used to retrieve and assemble statistical data for user specified geographic areas. The statistics are then tabulated in a convenient report [5].

Two categories of building blocks are defined by Statistics Canada. They are:

1. *Street block-face.* A block-face is defined as one side of a city street between consecutive intersections with other streets.
2. *Census Enumeration Area (EA).* An enumeration area generally contains 150-200 households.

The coordinate system chosen is known as the Universal Transverse Mercator (UTM) System.

Figure 3/ Universal Transverse Mercator Zones for Ontario

3.1/ Universal Transverse Mercator System

The Universal Transverse Mercator (UTM) System is used to specify point locations on the globe. The system divides the earth's surface into zones which are six degrees of longitude in width. Each zone has a central meridian forming its vertical axis. The horizontal axis is formed by the earth's equator.

The system divides the globe into 60 vertical zones. Sixteen zones, bearing numbers 7 to 22, cover the land mass of Canada. The Province of Ontario is covered by zones 15-18. Figure 3 depicts the UTM-Zones for Ontario.

Since the width of a zone varies with the degree of latitude, distances are measured on a plain rectangular grid onto which the zone's surface features have been projected. In UTM, point-locations within a zone are based on two distances in metres (one easting, one northing) from the zone axis. Northings begin at 0 at the equator. The central meridian is assigned a value of 500 000 m easting.

3.2/ Area Master File

In GRDSR, geographic base files at the block-face level are called Area Master Files (AMF). An Area Master File references every street, address range, block-face and centroid coordinate in the area covered. Other features, such as railroad tracks, rivers and municipal boundaries are included in the file [6]. Figure 4 depicts the contents of an Area Master File.

Appendix A shows the areas in Canada where Area Master Files have been completed. Major urban areas in the Province are included in the list.

Statistics Canada plans to update its Area Master Files semi-annually. The Area Master File is available from the CANSIM Division of Statistics Canada. The service charge is $75 for each Census Area or Census Metropolitan Area, and $300 for all files in the data base. Area Master Files on magnetic tape will be delivered to customers within one week.

Statistics Canada is prepared to provide assistance and create Area Master Files for areas not in Appendix A [4]. The user must provide a large scale, current street map showing block-face address ranges, together with an up-to-date street index.

3.3/ Geocoding at the Block-Face Level

Geocoding starts with an accurate street map, which has been divided into sections. Nodes are placed wherever streets intersect, end, or curve sharply, or to approximate the outline of features such as rivers, highways, and municipal boundaries. An overlay is prepared for each map section. The position of each node is marked on the overlay.

Digitizing of the nodes is done by laying the overlay on a digitizing table that connects to digitizing and key punch machines. The digitizing machine gives coordinates (one easting and one northing) of points on the table relative to the two axes of origin. Node numbers are key-edited through the key board of the digitizer. Coordinates of the nodes are obtained by positioning the pointer to the nodes. The output is a punched-card file containing node numbers and digitized coordinates. Several control points whose UTM coordinates are known, are also digitized at this time.

UTM coordinates for the nodes are calculated from the digitized coordinates using the control points. A centroid coordinate is calculated for each pair of nodes which forms the beginning and end of a valid address range. The centroid location is a point equidistant from two nodes bordering an address range and set back a distance of 22 m from the street centre-line.

3.4/ Geocoding at the Census Enumeration Area Level

For areas in Canada not covered at the block-face level, the 1971 Census Enumeration Areas are used for the geocoding operation. Two methods are used to determine the position of the centroid of the Enumeration Area. In urban areas, where population density is uniform, centroids are assigned to the EA geometric centre. Otherwise, a centroid is a point representing the centre of population.

MUNIC CODE	FEATURE CODE	SEQ. NO.	STREET NAME	TYPE	DIR.	NODE NO.	NODE COORD X	NODE COORD Y	ADDRESS BEFORE L	ADDRESS BEFORE R	ADDRESS AFTER L	ADDRESS AFTER R	CENTROID LEFT X	CENTROID LEFT Y	CENTROID RIGHT X	CENTROID RIGHT Y	INTERSECTING FEATURES
4835	59600		FREDSON	DR	SE												
		040E				08912	706964	5651540	168	171	–	–	706868	5651755	706861	5651673	FROBISHER BV.
		035				08874	706844	5651755	–	–	–	–	–	–	–	–	–
		030				08873	706771	5651722	–	83	–	95	–	–	706635	5651700	FRASER RD.
		025				08872	706733	5651729	–	–	–	–	–	–	–	–	–
		020				08871	706631	5651722	–	–	58	–	706516	5651734	–	–	FULHAM ST.
		015				08870	706497	5651711	–	15	–	25	–	–	706452	5651687	FULLERTON RD.
		0108				08869	706406	5651707	–	–	–	15	–	–	–	–	FAIRMONT DR.

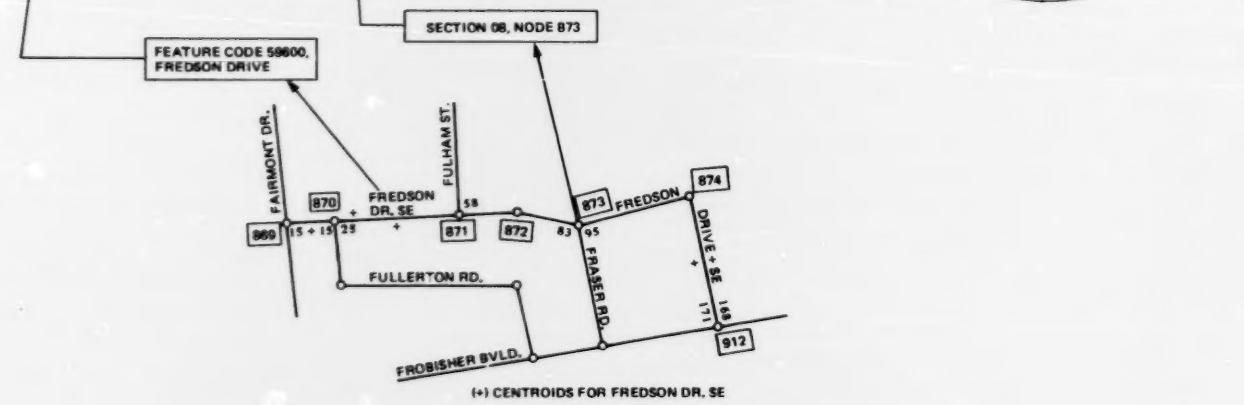


Figure 4/ The Area Master File (Special Format)

4/ Methodology for Assigning Geocodes to Postal Codes

The Canadian postal code offers a unique reference system which in many applications provides a more convenient means of identifying a place than the street address. A postal code specifies a city block, an apartment building, a postal station, etc. As a result, no information can be disseminated in such a way as to identify an individual respondent.

The postal code is composed of six alphanumeric characters and takes only six bytes storage in the computer. Certainly it will require less storage than the street address. Checking, sorting and searching can be performed more efficiently with postal codes.

In general, assigning geocodes to postal codes in urban areas means giving the X and Y coordinates to the centroid of a city block or the exact location of an apartment/office building. For postal codes denoting a service from a post office, a postal station or a specific post office as in rural areas, the X and Y coordinates show the location of the post office or postal station only. These coordinates may be a long way from the arterial street address.

4.1/ Assigning Geocodes to Postal Codes in Urban Areas

After discussions with Statistics Canada, Canada Post and the Demand Analysis Office at MTC, the Transport and Vehicle Systems Research and Development Office developed a methodology of assigning geocodes to postal codes in *urban areas*.

4.1.1/ Urban Areas with Area Master Files

There are a number of similarities between the Postal Code Directory and the Area Master File. These are:

1. Street addresses are stored in both files.
2. An address number range is defined for each block-face in the Area Master File and for each city-block in the Postal Code Directory. Address number ranges in both files may not be identical.
3. In the Area Master file, all street addresses along a block-face share the coordinates of the block-face centroid. In the Postal Code Directory, all street addresses along a city-block share the same postal code.

Two methods are used to assign geocodes to postal codes creating postal code-geocode files. These are:

1. *Block-Face Method*—Combining an Area Master file supplied by Statistics Canada with a Postal Code Directory supplied by Canada Post for those areas where geocoding has been completed at the block-face level.
2. *Digitizing Method*—Digitizing postal codes manually for areas where street names and address number ranges are not in the Area Master Files.

4.1.1.1/ Block-Face Method

This method matches street names and address number ranges in the Postal Code Directory with those in the Area Master File. Two computer programs were developed, converting street addresses in both files to the same format for matching. Abbreviations are used for street types and directions. Centroids (mid-point of the city block) for postal codes are calculated. Tables 3 and 4 depict the contents of an Area Master File and a Postal Code Directory in modified format.

A computer program was developed merging grid coordinates in the Area Master File and postal codes in the Postal Code Directory. The merging process was done in the following steps:

1. Sort street addresses in both files in alphabetical order.
2. Match both files by street names and address number ranges. The Area Master File forms the basis for matching.
3. Link grid coordinates and postal codes if:
   a) street names are identical, and
   b) one of the following conditions is satisfied
      i) address number ranges are identical;
      ii) the centroid of the postal code is within the address number range in the Area Master File;
      iii) the starting house number of the postal code is within the address number range in the Area Master File;
      iv) the ending house number of the postal code is within the address number range in the Area Master File.
4. Records in the Postal Code Directory file not satisfying conditions 3a and 3b are rejected. For these records, the following tasks are performed:
   a) Correct errors in spelling of street names and abbreviations for street types and directions in the Postal Code Directory according to those in the Area Master File.
   b) Repeat steps 1-3 in the merging process.
5. Records rejected after step 4 are assigned with grid coordinates using the Digitizing Method.

Table 3/ Area Master File (Statistics Canada)

Street Name	Type	Direction	From	To	UTM-X	UTM-Y	From	To	UTM-X	UTM-Y
Barrie	AV		66	68	672053	4861734				
Barrie	AV		70	74	672122	4861758				
Barrie	AV		98	134	672211	4861788	109	145	672225	4861747
Basswood	AV		965	1011	674628	4862862	960	1012	674642	4862820
Basswood	CT		1031	1063	674804	4862914	1036	1066	674812	4862870
Beatrice	ST	E					385	385	671529	4866222
Beatrice	ST	W	15	49	670420	4865594	20	46	670405	4865636
Beatrice	ST	W	59	125	670223	4865524	70	126	670207	4865565

Table 4/ Postal Code Directory (Canada Post)

Street Name	Type	Direction	Postal Area	Street Number From	Street Number To	Centroid	Postal Code
Barrie	AV		Oshawa	109	145	127	L1H2L4
Barrie	AV		Oshawa	66	74	70	L1H2L2
Barrie	AV		Oshawa	98	134	116	L1H2L3
Basswood	AV		Oshawa	965	1011	989	L1H2G8
Basswood	AV		Oshawa	960	1012	986	L1H2G7
Basswood	CT		Oshawa	1031	1063	1047	L1H2G9
Basswood	CT		Oshawa	1036	1066	1052	L1H2H1
Beatrice	ST	E	Oshawa	385	385	385	L1G7L4
Beatrice	ST	E	Oshawa	50	50	50	L1G7C8
Beatrice	ST	E	Oshawa	92	110	102	L1G6S4
Beatrice	ST	W	Oshawa	21	49	35	L1G3M6
Beatrice	ST	W	Oshawa	59	125	93	L1G3M7
Beatrice	ST	W	Oshawa	209	227	219	L1G7M9
Beatrice	ST	W	Oshawa	20	46	34	L1G3M5
Beatrice	ST	W	Oshawa	70	126	98	L1G3M8
Beatrice	ST	W	Oshawa	214	244	230	L1G7M9

4.1.1.2/ Digitizing Method

This method is similar to the geocoding at the block-face level. Manual digitizing of centroids of postal codes is done by laying the postal code map on the digitizing table that connects to a digitizing machine and a key-punch machine. Non-matchable postal codes are identified on the postal code map. Two numbers (one easting and one northing, say D-X and D-Y) are coded for the centroid that represents the postal code.

Converting these numbers generated by the digitizer to UTM grid coordinates, two reference points on the postal code map are identified and digitized. The UTM-X and UTM-Y coordinates of these reference points are obtained from the Area Master File.

A computer program was developed to convert the numbers (D-X and D-Y) generated by the digitizer to grid coordinates (UTM-X and UTM-Y) using geometric translations and rotations and the two reference points.

Table 5 depicts the contents of a postal code-geocode file.

The UTM coordinates are converted to four digit numbers by shifting the zone axis. These numbers, measuring distances in tenths of a kilometre from the shifted zone axis, are used for carpool matching.

Table 5/ Postal Code-Geocode File (MTC)

Street Name	Type	Direc-tion	Postal Area	Street Number from	to	Centroid	Postal Code	D-X	D-Y	UTM-X	UTM-Y	Carpool Matching Coordinates Pool X	Pool Y
Barrie	AV		Oshawa	109	145	127	L1H2L4			672225	4861747	1519	1260
Barrie	AV		Oshawa	66	74	70	L1H2L2			672122	4861758	1518	1261
Barrie	AV		Oshawa	98	134	116	L1H2L3			672211	4861788	1519	1261
Basswood	AV		Oshawa	965	1011	989	L1H2G8			674628	4862862	1543	1272
Basswood	AV		Oshawa	960	1012	986	L1H2G7			674642	4862820	1543	1271
Basswood	CT		Oshawa	1031	1063	1047	L1H2G9			674804	4862914	1545	1272
Basswood	CT		Oshawa	1036	1066	1052	L1H2H1			674812	4862870	1545	1272
Beatrice	ST	E	Oshawa	385	385	385	L1G7L4			671529	4866222	1512	1305
Beatrice	ST	E	Oshawa	50	50	50	L1G7C8	29425	34631	670656	4865712	1504	1300
Beatrice	ST	E	Oshawa	92	110	102	L1G6S4	29341	33453	670791	4865764	1505	1301
Beatrice	ST	W	Oshawa	21	49	35	L1G3M6			670420	4865594	1501	1299
Beatrice	ST	W	Oshawa	59	125	93	L1G3M7			670223	4865524	1499	1298
Beatrice	ST	W	Oshawa	209	227	219	L1G3M9	30147	41693	669836	4865432	1495	1297
Beatrice	ST	W	Oshawa	20	46	34	L1G3M5			670405	4865636	1501	1299
Beatrice	ST	W	Oshawa	70	126	98	L1G3M8			670207	4865565	1499	1299
Beatrice	ST	W	Oshawa	214	244	230	L1G7M9	30147	41693	669836	4865432	1495	1297

4.1.2/ Urban Areas Without Area Master Files

The areas for which Area Master Files already exist are listed in Appendix A. In order to use the Block-Face method in other areas, Area Master Files must be created. Statistics Canada is prepared to provide assistance in creating Area Master Files for any urban area. The urban areas in Ontario are listed in Table 6.

The Geocoding Unit of Statistics Canada has more than ten years experience in geocoding street addresses. Methods and procedures are well established and tested. The Unit is also well equipped with various kinds of digitizing machines. It is easier for the Unit to create an Area Master File. The results will be more reliable than those created by an individual.

Alternatively, the digitizing method may be used. Local Delivery Unit maps, a digitizing machine and a key punch machine are required to do that. The Local Delivery Unit maps may be difficult to obtain from Canada Post since there is usually only one copy which is being continually updated.

The creation of new Area Master Files and the use of the Block-Face Method is recommended as the preferred approach.

Table 6/ Urban Areas in Ontario

Acton	Concord	Kapuskasing	Orangeville	Simcoe
Ajax	Cornwall	Kenora	Orillia	Smiths Falls
Amherstburg	Delhi	Keswick	*Oshawa	Stratford
Arnprior	Dryden	*Kingston	*Ottawa	Strathroy
Aurora	Dunnville	Kingsville	Owen Sound	*Sudbury
Aylmer West	Elliot Lake	Kirkland Lake	Paris	*Thornhill
Barrie	Elmira	*Kitchener-Waterloo	Parry Sound	*Thunder Bay
Belleville	Essex	Leamington	Pembroke	Tillsonburg
Bowmanville	Fergus	Lindsay	Perth	Timmins
*Brampton	Fort Erie	Listowel	Petawawa	*Toronto
*Brantford	Fort Francis	*London	*Peterborough	Trenton
Brockville	Gananoque	Markham	*Pickering	Wallaceburg
*Burlington	Georgetown	Midland	Port Colborne	Welland
*Cambridge-Galt	Goderich	Milton	Port Hope	*Windsor
*Cambridge-Hespeler	Grimsby	*Mississauga	Renfrew	*Woodbridge
*Cambridge-Preston	*Guelph	Napanee	*Richmond Hill	Woodstock
Carleton Place	*Hamilton	Newmarket	*St Catharines	
Chatham	Hanover	*Niagara Falls	St Thomas	
Cobourg	Hawkesbury	*North Bay	*Sarnia	
Collingwood	Ingersoll	*Oakville	*Sault Ste. Marie	

*Area Master Files available from Statistics Canada

4.2/ Assigning Geocodes to Postal Codes in Rural Areas

One postal code is used to represent a rural area. This postal code indicates a specific post office in the area. Digitizing the location of the post office will give one set of coordinates for the rural areas.

These coordinates do not indicate the exact locations of street addresses in rural areas. They may be far away from the original locations which is a serious drawback to using postal codes for geographical referencing in rural areas.

Assigning geocodes to postal codes in rural areas in this manner does not create serious problems in carpool matching since the matching process is based on relative coordinates and people living in nearby rural areas will still be grouped together and matched.

4.3/ Areas on the UTM Zone Boundaries

The Universal Transverse Mercator System divides the land mass of Ontario into four zones. Places belonging to different UTM zones may have exact coordinate values. Areas on the zone boundaries will be referenced by two different coordinate systems. This could cause problems with a postal code-geocode conversion system for the Province. A possible solution is to convert the UTM coordinates of different zones into one system.

5/ Postal Code-Geocode Files for Areas in Southern Ontario

Table 7 depicts the areas where postal code-geocode files have been created by the Transport and Vehicle Systems Research and Development Office.

Table 7/ Postal Code-Geocode Files for Areas in Southern Ontario

Area	Number of Postal Codes
Metropolitan Toronto	43 844
Oshawa	3 587
*Brampton	2 765
*Mississauga	6 417
*Oakville	2 476
*Woodbridge	343
*Thornhill	1 096
*Markham	1 022
*Richmond Hill	810
*Pickering	874
*Ajax	512
*Newmarket	921
*Whitby	1 047
TOTAL	65 714

*To simplify the digitizing task, a single geocode is used to represent both sides of the street

5.1/ Postal Code-Geocode File for Metropolitan Toronto

The 1976 Area Master Files and the 1979 Postal Code Directory were used to create the postal code-geocode file for Metropolitan Toronto.

Metropolitan Toronto is composed of six municipalities, namely, Etobicoke, Scarborough, City of Toronto, York, East York, and the City of North York. Statistics Canada supplied six Area Master Files for Metropolitan Toronto, one for each municipality. Canada Post has created only one postal code directory for these municipalities. Difficulties were found in matching the six Area Master Files and the Postal Code Directory because of duplicate street addresses in different municipalities.

The following method was used to solve the duplicate street address problem.

1. Identifying Forward Sortation Areas. Some Forward Sortation Areas were totally included in a municipality. A conversion table was formed, having the Forward Sortation Area and corresponding muncipality code (Table 8). A different code was assigned to those Forward Sortation Areas that were covered by two or more municipalities.

Table 8/ Postal Code-Geocode File for Metropolitan Toronto Summary of Matching Results

Municipality	Code	Block-Face Method	Digitizing Method	Total
Etobicoke	11	7 471 (94.8%)	408 (5.2%)	7 879
Scarborough	12	7 287 (89.3%)	871 (10.7%)	8 158
City of Toronto	13	6 221 (95.8%)	274 (4.2%)	6 495
East York	15	498 (95.6%)	23 (4.4%)	521
City of North York	16	8 146 (93.3%)	584 (6.7%)	8 730
*Others	10	11 847 (98.2%)	214 (1.8%)	12 061
TOTAL		41 470 (94.6%)	2 374 (5.4%)	43 884

*Postal Codes for areas belonging to different municipalities (including the borough of York).

2. Sorting the records in the postal code directory according to the conversion table. Six files were created from the postal code directory for Metropolitan Toronto. The first five files, namely, Etobicoke, Scarborough, City of Toronto, East York, and City of North York, consisted of records that were totally included in the municipality. The last file, namely Others, consisted of records belonging to different Municipalities and the borough of York.
3. Matching the first five files with corresponding Area Master Files using the Block-Face method. Rejected postal codes were digitized manually using the Digitizing method.
4. Matching the sixth file with the six Area Master Files for Metropolitan Toronto individually. Six matching output files, one for each municipality, were produced. Postal Codes of duplicate street addresses in different municipalities were matched twice or more and stored in different matching output files. Manual adjustments were made to these postal codes by checking their locations in the Local Delivery Unit maps.

Output matching files were combined to form the Postal Code-Geocode File for Metropolitan Toronto. Separate geocodes were given for block faces on opposite sides of the street even when digitizing was done on a digitizer.

The present file for Metropolitan Toronto contains 43 844 postal codes, of which 41 470 (94.6%) were matched automatically from the Area Master File and the Postal Code Directory. The remaining 2374 (5.4%) were assigned manually on a digitizer. Table 8 depicts the matching results for Metropolitan Toronto.

5.2/ Postal Code-Geocode File for Oshawa

A postal code-geocode file for Oshawa has been completed using the 1981 Area Master File and the 1981 Postal Code Directory. Table 9 depicts a summary of the matching results. Of 3659 postal codes, 3445 (94.2%) were assigned automatically with geocodes by matching street names and address number ranges in both files. Manual digitization was required for 142 (3.8%) of the postal codes, and 72 (2%) could not be identified on postal code maps.

5.3/ Postal Code-Geocode Files for Brampton, Mississauga, Oakville, Woodbridge, Thornhill, Richmond Hill and Pickering

The 1971 Area Master Files and the 1979 Postal Code Directories were used to create the postal code-geocode files for these areas. Because of the 1971 street addresses in the Area Master Files, the matching percentages ranged from 55% to 85%. Postal codes of nearby areas, such as opposite sides of the street, were grouped together under one centroid to simplify the digitizing task.

5.4/ Postal Code-Geocode Files for Markham, Ajax, Whitby and Newmarket

Area Master Files for these areas were not available from Statistics Canada. The Digitizing method was used to create the postal code-geocode files for these areas. National Topographical Maps produced by the Department of Energy, Mines, and Resources were used to identify the control (reference) points.

The matching results for Metropolitan Toronto and Oshawa showed that at least 94% of the postal codes could be assigned with geocodes using the Block-Face Method. The time and cost required to create the file depends on the size of the study area, and the matching percentage by the computer. The most time consuming tasks are:

a) manual checking of duplicate addresses,
b) correcting errors in spelling of street names, and
c) locating non-matchable postal codes on postal code maps.

The 1980 Postal Code Directory showed an increase of 432 (1%) postal codes for Metropolitan Toronto, and of 3667 (21%) for surrounding areas, compared with the 1979 Directory. Bi-yearly update of the postal code-geocode file for Metropolitan Toronto and yearly update for surrounding areas is recommended.

Table 9/ Postal Code-Geocode File for Oshawa Summary of Matching Results

Number of records in the Postal Code Directory File	3659	
(I) Block-Face Method		
A. Original street addresses in the Postal Code Directory		
1. Identical street name and address number ranges	2683	
2. Identical street name and centroid of postal code within the address number range in the AMF	551	
3. Identical street name and starting house number of postal code within the address number range in the AMF	43	
4. Identical street name and ending house number of postal code within the address number range in the AMF	20	
SUB-TOTAL	3297	(90.2%)
B. Modified street addresses in the Postal Code Directory		
1. Identical street name and address number ranges	119	
2. Identical street name and centroid of postal code within the address number range in the AMF	25	
3. Identical street name and starting house number of postal code within the address number range in the AMF	2	
4. Identical street name and ending house number of postal code within the address number range in the AMF	2	
SUB-TOTAL	148	(4%)
C. Identical street name but non-matchable address number ranges	138	(3.8%)
D. Non-matchable street name	76	(2%)
(II) Digitizing Method		
1. Manual digitizing of postal codes	142	(3.8%)
2. Postal codes not identified on postal code map	72	(2%)

6/ Methodology for Converting Postal Codes to Traffic Zones

Manual coding of traffic zones for home addresses presents similar problems to converting home addresses to grid coordinates. It is a time consuming and costly element in creating the origin/destination matrix for transportation planning.

6.1/ Geocode Method

The following discussions present the methodology for converting postal codes to traffic zones. The method is to use the coordinates in the postal code-geocode file.

6.1.1/ Assumptions

1. Unique matching between postal codes and grid coordinates. Two postal codes showing different locations cannot have the same grid coordinates.
2. No space gaps, overlaps and embedments between traffic zones. (Figure 5).
3. Zone boundaries must be straight lines. Figure 6 depicts a zone map with curved boundaries, which are modified to straight lines in Figure 7.
4. A unique centroid for each traffic zone must be located in the zone.

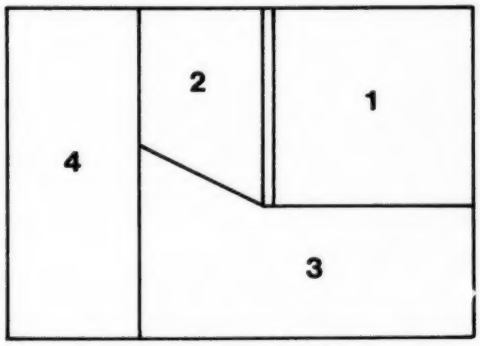
6.1.2/ Definitions

Terms are defined to make the description of the methodology easier. Figures 8 and 9 depict these terms.

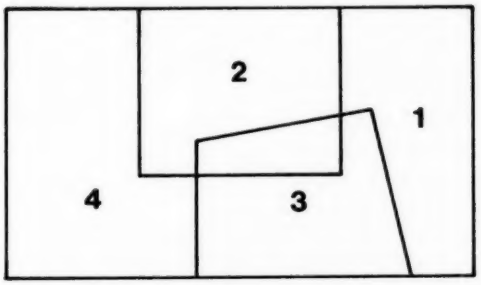
1. *Node*—A node is defined as a point on the traffic zone boundary at the junction of two boundary lines.
2. *Traffic Zone Centroid*—A centroid is defined as the centre of population of a traffic zone. Alternatively it may be any point within the zone boundary.
3. *Boundary Line*—A boundary line is a straight line joining a pair of nodes on a zone boundary. Joining a series of nodes by straight lines in a clockwise direction gives the zone boundary.
4. *X and Y Ranges of Traffic Zone*—The X and Y ranges give the lowest and highest grid coordinates for both axes of any node on the zone boundary, i.e., the coordinates of the four corners of the rectangle that wholly contains the traffic zone.
5. *Intersecting Lines*—Two lines are said to be intersected if they meet at a common point without the necessity of extending either line.

6.1.3/ Modification of the Postal Code-Geocode File

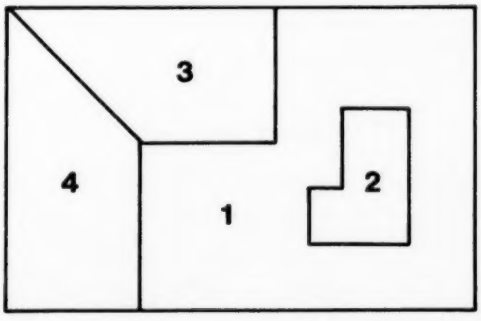
For areas such as Brampton, Mississauga, Oakville, etc., postal codes of nearby areas such as opposite sides of streets are grouped together under one centroid to simplify the digitizing task. This grouping does not affect, and is not critical to, carpool matching. However, it may be critical in transportation planning. It could cause problems where the zone boundary is the centreline of the street.



SPACE GAPS
(GAPS BETWEEN ZONE 1 AND ZONE 2)



OVERLAPS
(OVERLAPS BETWEEN ZONE 2 AND ZONE 3)



EMBEDMENTS
(ZONE 2 EMBEDDED IN ZONE 1)

Figure 5/ Space Gaps, Overlaps, and Embedments

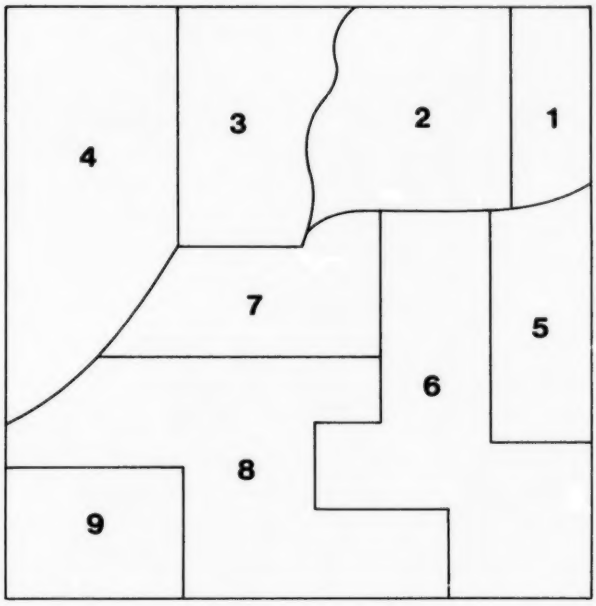


Figure 6/ Traffic Zones with Curved Boundaries

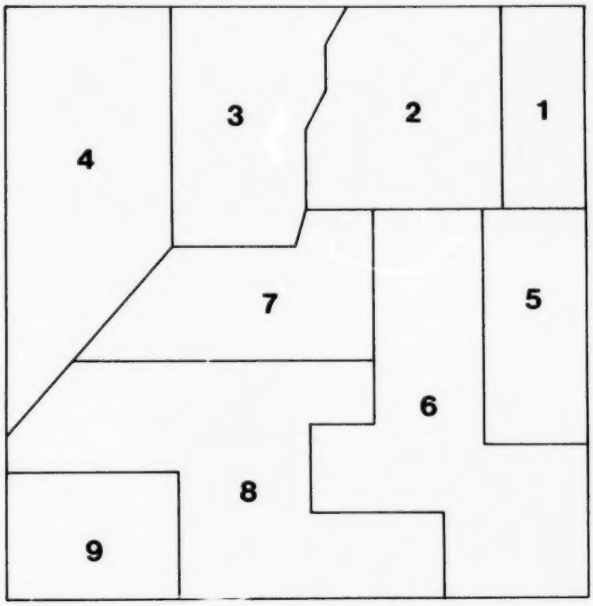


Figure 7/ Traffic Zones with Straight Line Boundaries

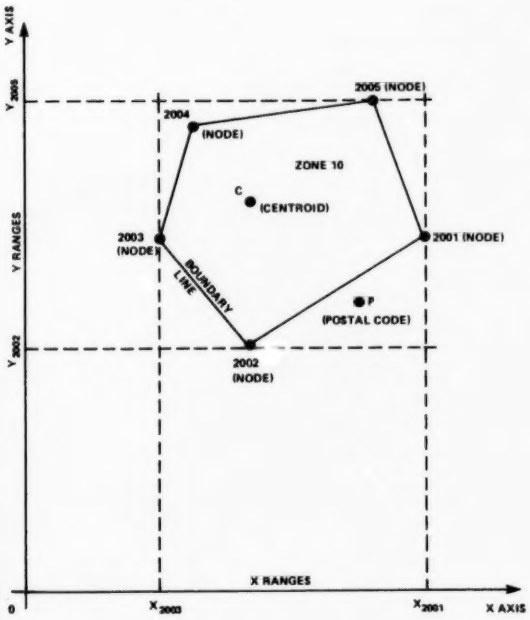


Figure 8/ Nodes, Centroid, Boundary Lines,
X and Y Ranges of Traffic Zone

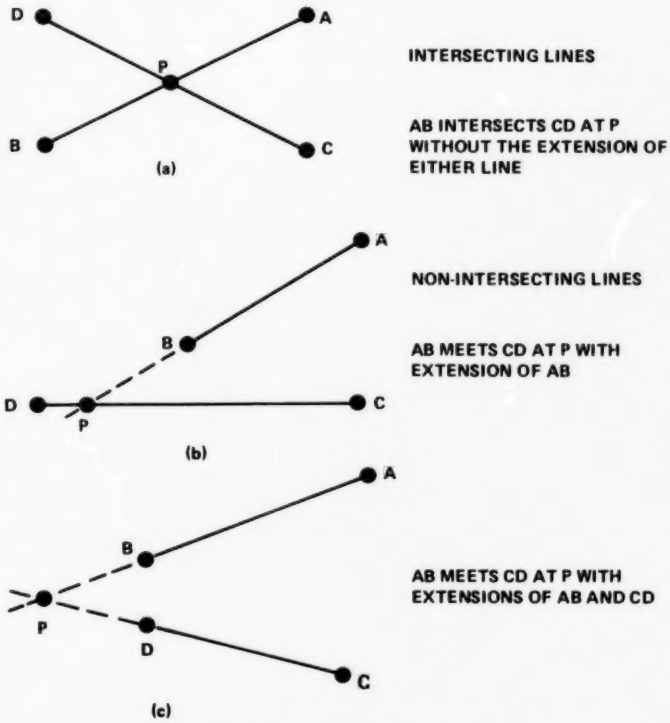


Figure 9/ Intersecting and Non-Intersecting Lines

To reflect this particular need, postal code-geocode files need to be modified to have one-to-one matching between postal codes and geocodes. In short, the solution is to recreate the postal code-geocode files for all the areas (except Oshawa and Metropolitan Toronto).

6.1.4/ Digitizing Zone Centroids and Nodes

Numeric numbers are used to represent zone centroids (1-2000) and nodes (2001, 2002, 2003, ...). Zone centroids and nodes are assigned international reference coordinates (UTM-X and UTM-Y) using the same digitizing method and grid coordinate system as for the postal codes. Two control points with known UTM-X and UTM-Y coordinates, zone centroids, and nodes are identified on the traffic zone maps. These points are digitized using the digitizing machine giving two numbers (D-X and D-Y). The computer program developed by the Transport and Vehicle Systems Research and Development Office converts these numbers back to the UTM System. A data file, Traffic Zone Boundary File, with zone centroid numbers, node numbers, corresponding UTM-X and UTM-Y coordinates and number of nodes in each zone is created. The digitizing of zone centroids and nodes can be requested from Statistics Canada. The user must identify the centroids and nodes on the traffic zone maps.

6.1.5/ Traffic Zone Boundary File

Traffic zone boundaries are identified by node numbers. They are coded consecutively in a clockwise direction. The starting node and the ending node must be the same node number forming a closed loop for the boundary. For each zone in the file the following information is stored.

1. Traffic zone number
2. UTM-X and UTM-Y of the centroid of the zone
3. The number of nodes (including the ending node which is the same node number as the starting node)
4. List of node numbers and corresponding grid coordinates

6.1.6/ Computer Program Creating Postal Code-Traffic Zone Conversion File

Input files to the program are:

1. Postal code-geocode file
2. Traffic zone boundary file

The following tasks give a description of the program logic:

1. *Sorting postal code-geocode file.* The postal code-geocode file is sorted in ascending order by postal codes.
2. *Checking of traffic zones.* For each postal code in the postal-geocode file, the following sub-tasks are performed to assign a traffic zone number to the postal code.

a) Checking of X and Y ranges of the study area. The coordinates of the postal code are compared with the X and Y ranges of the study area. Beyond these ranges means the postal code is outside the study area. Traffic zone number of zero value is assigned to the postal code.

b) Calculating distances to zone centroids. If the coordinates are inside the study area, distances to the centroids of the traffic zones are calculated. These distances and traffic zone numbers are stored in arrays which are sorted in sequence by distances.

c) Determining the position of the postal code.
   (i) Traffic zone boundary information of the first traffic zone (the nearest zone centroid to the postal code) in the array is obtained from the traffic zone boundary file
   (ii) A 'SEARCH' routine, determining whether the coordinates lie within the given zone, is performed. If the coordinates lie within the given zone, the traffic zone number of this zone is assigned to the postal code. Another record is read. The new coordinates are assumed to be within the same zone as the last. The 'SEARCH' routine is performed. If this is not the case, the distances to zone centroids are recalculated and stored.
   (iii) If the coordinates are not within the first zone, the second traffic zone (the next nearest zone centroid to the postal code) in the array is checked. This continues until the correct zone is found, or until the first five closest zones have been checked. If this occurs, a zero value traffic zone number is assigned to the postal code.

'SEARCH' Routine This routine checks the coordinates of a postal code against a given traffic zone. Three operations are performed in this routine.

1. *Checking of X and Y ranges of the traffic zone.* The coordinates of the postal code are compared with the X and Y ranges of the traffic zone. A postal code falling outside these ranges is not in that traffic zone.
2. *Determining points of intersection.* Each boundary line of the traffic zone is checked for intersection with the line parallel to the Y axis through the given coordinates of the postal code. The Y coordinates of the points of intersection are stored and sorted in ascending order.
3. *Checking the position of the postal code.* If the Y coordinate of the postal code lies between any consecutive pairs of these sorted intersections, the first of which is numerically odd, say I_1I_2, or I_3I_4 (Figure 10), the postal code is within the given traffic zone. Otherwise it is outside the traffic zone.

6.2/ Assigning Traffic Zones to Postal Codes in Rural Areas

In rural areas, rural routes often cover several zones and cross one or more municipal boundaries. Under the present postal code system, the postal code of a rural route indicates a specific post office. The coordinates assigned to the postal code in rural areas indicate the location of a specific post office only. Using the Geocode Method to assign traffic zones to postal codes in rural areas means assigning the traffic zone number of a specific post office to a rural route.

Assigning traffic zones to postal codes in rural areas in this way creates serious problems.

1/ If the specific post office is not located in any one of the traffic zones that the rural route covers, the whole rural route will be assigned to an incorrect traffic zone number.

2/ If the specific post office is located in one of the traffic zones that the rural route covers, that part of the rural route will be assigned with the right traffic zone number. The rest of the route will be assigned incorrectly.

One solution would be the modification of the postal codes in rural areas to represent each home address with a unique postal code. More investigation is required.

It is concluded that the present postal code system used for rural areas is not suitable for transportation referencing.

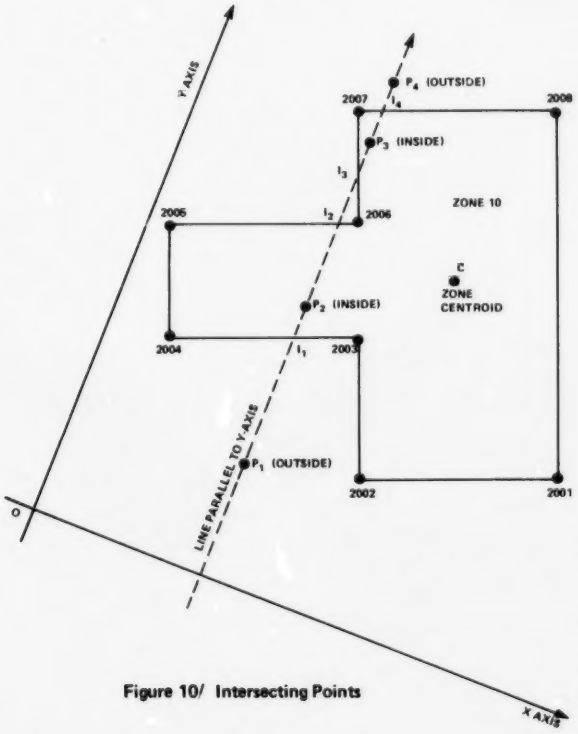


Figure 10/ Intersecting Points

Table 10/ Postal Code-Geocode-TARMS Traffic Zone File for Scarborough — May 1, 1981

Code	Record Number	Street Name	Postal Area	Street Number From	Street Number To	Postal Code	Metres East of a Line 500 km West of 81° W Longitude UTM-X	Metres North of the Equator UTM-Y	Carpool Matching Coordinates Pool X	Carpool Matching Coordinates Pool Y	TARMS Zone
12	1	Goodless Ct	Scarb	4	40	M1B1A1	642790	4850725	1225	1150	391
12	2	Griffen Dr	Scarb	1	7	M1B1A2	642732	4850763	1224	1151	391
12	3	Griffen Dr	Scarb	2	60	M1B1A3	642856	4850719	1226	1150	391
12	4	Griffen Dr	Scarb	17	81	M1B1A4	642934	4850692	1226	1150	391
12	5	Griffen Dr	Scarb	68	70	M1B1A5	642914	4850802	1226	1151	391
12	6	Gorsey Square	Scarb	3	79	M1B1A6	642803	4850838	1225	1151	391
12	7	Gorsey Square	Scarb	4	76	M1B1A7	642766	4850862	1225	1152	391
12	8	Berner Trail	Scarb	1	25	M1B1A8	642871	4850936	1226	1152	391
12	9	Berner Trail	Scarb	2	10	M1B1A9	642875	4850992	1226	1153	391
12	10	Berner Trail	Scarb	43	53	M1B1B1	642968	4850856	1227	1152	391
12	11	Berner Trail	Scarb	81	83	M1B1B2	642968	4850856	1227	1152	391
12	12	Berner Trail	Scarb	80	132	M1B1B3	643174	4851003	1228	1153	391
12	13	Berner Trail	Scarb	91	95	M1B1B4	643187	4850938	1229	1152	391
12	14	Berner Trail	Scarb	119	145	M1B1B5	643191	4850995	1229	1153	391
12	15	Berner Trail	Scarb	142	156	M1B1B6	643287	4851136	1230	1154	391
12	16	Nahanni Tr	Scarb	1	33	M1B1B7	642938	4851021	1226	1153	391
12	17	Nahanni Tr	Scarb	2	42	M1B1B8	642911	4851064	1226	1154	391
12	18	Nahanni Tr	Scarb	49	55	M1B1B9	642950	4851138	1227	1154	391
12	19	Cheatham Pl	Scarb	5	37	M1B1C1	642970	4850924	1227	1152	391
12	20	Cheatham Pl	Scarb	2	38	M1B1C2	642960	4850938	1227	1152	391
12	21	Howell Square	Scarb	1	87	M1B1C3	643047	4850775	1227	1151	391
12	22	Howell Square	Scarb	2	86	M1B1C4	643061	4850733	1228	1150	391
12	23	Hutcherson Square	Scarb	1	79	M1B1C5	643256	4850832	1230	1151	391
12	24	Hutcherson Square	Scarb	4	92	M1B1C6	643299	4850842	1230	1151	391
12	25	Hatchet Pl	Scarb	2	30	M1B1C7	643221	4851008	1229	1153	391
12	26	Blackwell Av	Scarb	2	12	M1B1C8	643199	4851139	1229	1154	391
12	27	Blackwell Av	Scarb	18	50	M1B1C9	643159	4851245	1229	1155	391
12	28	Blackwell Av	Scarb	27	85	M1B1E1	643150	4851301	1229	1156	391
12	29	Coxworth Ct	Scarb	1	89	M1B1E2	643293	4851235	1230	1155	391
12	30	Coxworth Ct	Scarb	2	84	M1B1E3	643249	4851227	1229	1155	391

7/ Postal Code-TARMS Traffic Zone Conversion File for Metropolitan Toronto

A computer program, TR01982, was developed by the Computer Systems Branch, MTC, adding traffic zone numbers to the postal code-geocode file. The traffic zone system is known as the Toronto Area Regional Model Study (TARMS) System. It divides Metropolitan Toronto into 400 traffic zones [7].

The digitizing of traffic zone boundaries was done by Statistics Canada. The staff of the Research Division of the Metropolitan Toronto Planning Department outlined the zone boundaries on large scale street maps. A zone boundary file was created and was used to add the TARMS zone numbers to the postal code-geocode file for Metropolitan Toronto. Traffic zone boundaries were plotted by computer. A visual comparison was made between computer plots and original maps.

All but 26 of the 43 844 postal codes were located within the given zone boundaries. In a test of the Scarborough area, 26 (0.3%) of 8158 postal codes were found to be assigned to the wrong zone.

The Postal Code-Geocode-Traffic Zone Conversion File for Metropolitan Toronto is available either in hard copy form or on magnetic tape. A sample copy is shown in Table 10. Requests should be addressed to James Wong of the Transport and Vehicle Systems Research and Development Office, MTC. A recovery cost is charged for copying the tape and the hard copy print-outs. Similar printouts sorted by street addresses, grid coordinates or any other parameter on the printout can be obtained.

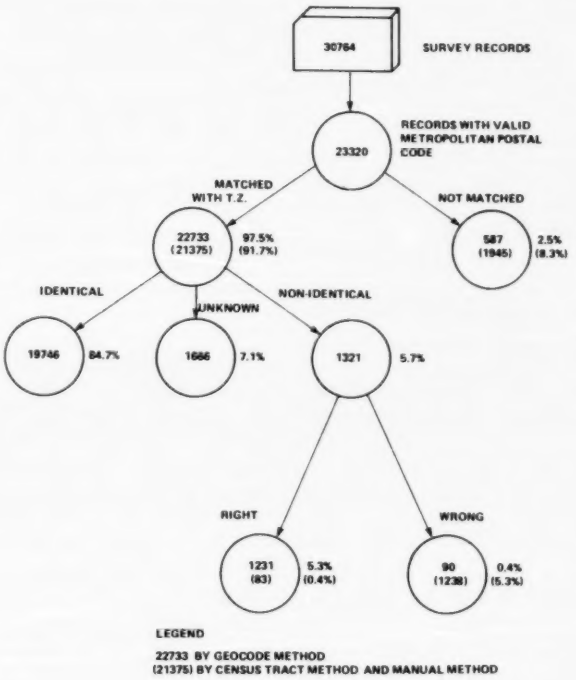


Figure 11/ Matching Results for the 1980 Metropolitan Toronto Employee Travel Survey

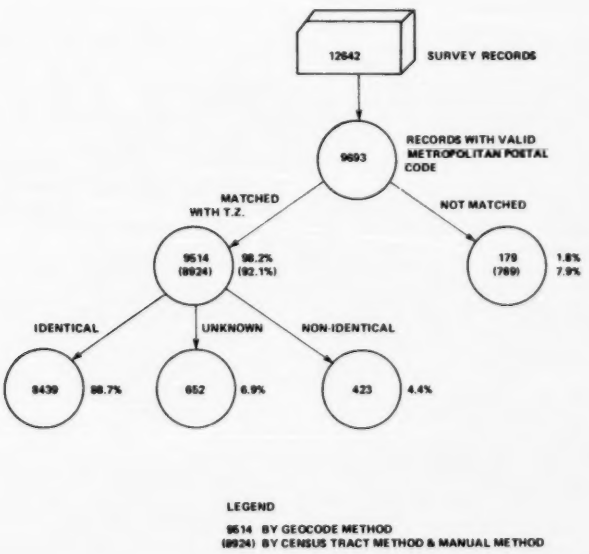


Figure 12/ Matching Results for the 1975 City of Toronto Employee Travel Survey

8/ Testing of Methodology for Converting Postal Codes to Tarms Traffic Zones

An alternative method of converting postal codes (representing residential addresses on a survey file) to TARMS traffic zones was developed jointly by staff of the Metropolitan Toronto Planning Department and Computer Systems Branch, MTC. A file prepared in 1976 was available from Statistics Canada giving Census Tract, Enumeration Area and other geographic data for Ontario Postal Codes. Metro Planning staff prepared a conversion listing from census tracts to traffic zones, and Computer Systems Branch staff wrote a program to read postal codes (sorted in sequence) from the survey file and append the corresponding traffic zones to each record. Some census tracts overlap two or more traffic zones; in these cases traffic zones were asigned manually. Addresses outside Metro Toronto and records for which postal codes could not be matched on the conversion file were also coded manually. Use of the Enumeration Area rather than census tract would have provided a more complete matching of traffic zones to postal codes; however, the amount of work required to create the Enumeration Area to traffic zone conversion table would have been prohibitive.

Two survey files, namely the 1980 Metropolitan Toronto Employee Travel Survey and the 1975 City of Toronto Employee Travel Survey, were used to test the two methods. Comparisons were made between the traffic zones assigned. Figures 11 and 12 depict the matching results, while Tables 11 and 12 illustrate the TARMS traffic zones attached to each survey.

8.1/ Matching Results for the 1980 Metropolitan Toronto Employee Travel Survey

In a test of 15 132 records, the geocode method was able to match automatically 98% of the records compared with 87.1% by the census tract method. In a test of 23 320 records with valid Metro postal codes, the geocode method was able to match 97.5% of the records automatically, compared with 91.7% by combined automatic and manual methods using census tracts. In a comparison of 21 375 records matched by both methods, it was found that 1321 (5.7%) were assigned different zone numbers. Manual checking showed 90 records (0.4%) given by the geocode method to be wrong, 1238 (5.3%) by the census tract method and 7 to be wrong by both methods.

8.2/ Matching Results for the 1975 City of Toronto Employee Travel Survey

In a test of 7781 records, the geocode method matched 98.3% of the records automatically, compared with 90.1% by the census tract method. Testing the 9693 records with valid Metro postal codes, the geocode method was able to match 98.2% of the records automatically, compared with 92.1% by combined automatic and manual methods using census tracts. In a comparison of 8924 records matched by both methods, it was found that 8439 (88.7%) were assigned with the same zone numbers and 423 (4.4%) with different zone numbers.

In conclusion, these results agree with those obtained from the 1980 Employee Travel Survey. The geocode method for assigning zone numbers to survey data is likely to be more accurate and reliable than the census tract method and any manual coding procedure. Since the postal code traffic zone conversion file for Metropolitan Toronto has already been created, the cost and time requirements in the use of the geocode method are likely to be substantially less than for other methods. The use of postal code in data coding provides added flexibility for future analysis (e.g., revised zone systems).

Table 11/ Assigning TARMS Traffic Zones to the 1980 Metropolitan Toronto Employee Travel Survey

Test	Method	No. of Records	Traffic Zone Assigned	Identical Traffic Zone	Non-Identical Traffic Zone	Traffic Zone not Assigned	Invalid Postal Code	Unmatched Postal Code
(1)	MTC (GEOCODE)	8504	7897 (92.9)	6864 (80.8)	1033 (12.1)	607 (7.1)	307 (3.6)	300 (3.5)
	METRO (MANUAL)	8504	8504 (100.0)					
(2)	MTC (GEOCODE)	13178	13170 (99.9)	12882 (97.8)	288 (2.1)	8 (0.1)	0 (0.0)	8 (0.1)
(3)	MTC (GEOCODE)	1954	1666 (85.3)	N.A.	N.A.	288 (14.7)	9 (0.4)	279 (14.3)
(2) + (3)	MTC (GEOCODE)	15132	14836 (98.0)			296 (2.0)		
	METRO (CENSUS TRACT)	15132	13178 (87.1)			1954 (12.9)		

Table 12/ Assigning TARMS Traffic Zones to the 1975 City of Toronto Employee Travel Survey

Test	Method	No. of Records	Traffic Zone Assigned	Identical Traffic Zone	Non-identical Traffic Zone	Traffic Zone not Assigned
(1)	MTC (GEOCODE)	7012	6998 (99.8)	6848 (97.7)	150 (2.1)	14 (0.2)
(2)	MTC (GEOCODE)	769	652 (84.8)	N.A.	N.A.	117 (15.2)
(1) + (2)	MTC (GEOCODE)	7781	7650 (98.3)			131 (1.7)
	METRO (CENSUS TRACT)	7781	7012 (90.1)			769 (9.9)
(3)	MTC (GEOCODE)	1912	1864 (97.5)	1591 (83.2)	273 (14.3)	48 (2.5)
	METRO (MANUAL)	1912	1912 (100.0)			
(1) + (2) + (3)	MTC (GEOCODE)	9693	9514 (98.2)			179 (1.8)
	METRO (MANUAL + CENSUS TRACT)	9693	8924 (92.1)			769 (7.9)

9/ Costs and Savings of Postal Code-Geocode-Traffic Zone Conversion File

The time and cost required to create the postal code-geocode-traffic zone conversion file depends on the size of the study area and the percentage of matching that can be done by the computer. The most time consuming tasks are:

1. manual checking of duplicate street addresses
2. correcting errors in spelling of street names
3. locating non-matchable postal codes on postal code maps
4. identifying traffic zone boundaries on street maps
5. digitizing traffic zone boundaries

For Metropolitan Toronto, the creation of the postal code-geocode-traffic zone file having 43 844 postal codes (43% of postal codes in Central Ontario) took 8 - 10 man-months. The computing costs were in the range of $1500 - $2000.

Most of the urban areas in Ontario (except Toronto, London, Hamilton, Kitchener-Waterloo, Ottawa and Mississauga, etc.) have less than 5000 postal codes. The average development time for each of these urban areas will be one man-month. The computing cost will be in the range of $200 - $300.

Using the manual method, the average time and cost for converting street addresses to traffic zones is 1 min and 10¢ per street address. That means it would cost 64 man-days and $2300 to assign the 1980 Metropolitan Toronto Employee Travel Survey records with traffic zones.

Using the postal code-traffic zone file, it takes 3 man-days (one day for the computing run and two days for manual coding of non-matchable and incorrectly assigned postal codes) and $80 (including $20 for computing cost).

It is concluded that the postal code-geocode-traffic zone file provides more reliable results and a substantial saving of time and money.

10/ Potential Uses of the Postal Code-Geocode-Traffic Zone Conversion File

The postal code-geocode-traffic zone conversion file can serve many areas besides carpool matching and origin/destination survey. The following outlines its possible uses:

1. Planning - Converting household interview and survey data to planning zones. Analysis of household, employment or travel data by geographical area or by distance from major routes, transit stops etc.
2. Routing - Delivery of goods. Scheduling of handicapped services, taxis and dial-a-bus, etc. Dispatching of emergency vehicles.
3. Record keeping - Any type of record which might be maintained by geographical area, e.g., accident records, illnesses, fires, housing, employment, deliveries and orders.

11/ Expanding the Postal Code-Geocode-Traffic Zone Conversion System to Other Urban Areas in Ontario

The present postal code-geocode-traffic zone conversion system assigns TARMS traffic zones to postal codes in Metropolitan Toronto.

The following gives an outline of the tasks necessary to expand the conversion system to other urban areas in Ontario

1. Identify areas in Ontario for the conversion system
2. Obtain Area Master Files (AMF) from Statistics Canada
3. Obtain Postal Code Directory from Canada Post
4. Obtain Postal Code Maps from Canada Post
5. Create Postal Code-Geocode File from Postal Code Directory and Area Master File
6. Resolve problems related to geocoding
   a) Areas on zone boundaries
   b) Rural areas
7. Create Postal Code-Traffic Zone Conversion File
   a) Obtain street maps of study areas
   b) Identify zone boundaries
   c) Digitize zone boundaries
   d) Plot zone boundaries and make visual comparison between computer plots and original maps

12/ References

[1] *Postal Code Directory - Ontario Postal Region*, March 1979-1980.

[2] *Postal Code Directories on Magnetic Tape*, Marketing Planning Branch, Canada Post, April 1979.

[3] *Allocation of Area Code Designators*, Canada Post, June 25, 1980.

[4] *The Geographically Referenced Data Storage and Retrieval (GRDSR) System - An Introduction*, Statistics Canada, June 1972.

[5] *The Geographically Referenced Data Storage and Retrieval (GRDSR) System - A Technical Description*, Statistics Canada, June 1972.

[6] *The Geographically Referenced Data Storage and Retrieval (GRDSR) System, Area Master File Documentation*, Statistics Canada, October 1973.

[7] *Toronto Area Regional Model Study, Modal Split*, Planning Branch, Department of Highways, Ontario, June 1970.

APPENDIX A

AREA MASTER FILES FOR AREAS IN CANADA (1981)

(A) Areas in Ontario

Place Name	CA/CMA*	Census Sub-Division
Brantford	CA	Brantford
Guelph	CA	Guelph
Hamilton	CMA	Burlington
		Hamilton
Kingston	CMA	Kingston
Kitchener	CMA	Cambridge
		Kitchener
		North Dumfries
		Waterloo
		Wellesley
		Wilmot
		Woolwich
London	CMA	London
North Bay		North Bay
Oshawa	CMA	Oshawa
Ottawa-Hull	CMA	Aylmer
		Gatineau
		Gloucester
		Hull
		Kanata
		Nepean
		Ottawa
		Rockcliffe Park
		Vanier
Peterborough	CA	Peterborough
Sarnia	CA	Point Edward
		Sarnia
		Sarnia 45
Sault Ste. Marie	CA	Rankin Location 15D
		Sault Ste. Marie
St. Catharines-Niagara	CMA	Niagara Falls
		St. Catharines
Sudbury	CMA	Sudbury
Thunder Bay	CMA	Thunder Bay
Toronto	CMA	Brampton
		East York
		Etobicoke
		Mississauga
		North York
		Oakville
		Pickering
		Richmond Hill
		Scarborough
		Toronto
		Vaughan
		York
Windsor	CMA	Windsor

(B) Areas in other Provinces

Place Name	CA/CMA*	Census Sub-Division
Calgary	CMA	Calgary
Chicoutimi-Jonquière	CMA	Chicoutimi
		Jonquière
Edmonton	CMA	Edmonton
Halifax	CMA	Dartmouth
		Halifax
Montréal	CMA	Anjou
		Baie-D'Urfé
		Beaconsfield
		Boucherville
		North Vancouver
		Port Coquitlam
		Port Moody
		Richmond
		Semiahmoo
		Surrey
		Tsawwassen
		University Endowment Area
		Vancouver
		West Vancouver
		White Rock
Victoria	CMA	Capital, Sued. B
		Central Saanich
		Esquimalt
		Oak Bay
		Saanich
		Victoria
		Brossard
		Côte-Saint-Luc
		Dollard-des-Ormeaux
		Dorval
		Greenfield Park
		Hampstead
		Ile Dorval
		Kirkland
		Lachine
		LaSalle
		Laval
		Lemoyne
		Longueuil
		Mont-Royal
		Montréal
		Montréal-Est
		Montréal-Nord
		Montréal-Ouest
		Outremont
		Pierrefonds
		Pointe-aux-Trembles
		Pointe-Claire
		Roxboro
		Saint-Bruno-de-Montarville
		Saint-Hubert
		Saint-Jean-de-Dieu
		Saint-Lambert
		Saint-Laurent
		Saint-Leonard
		Saint-Pierre
		Saint-Raphael-de-L'Ile-Bizard
		Sainte-Anne-de-Bellevue
		Sainte-Geneviève
		Senneville
		Verdun
		Westmount
Québec	CMA	Ancienne-Lorette
		Beauport
		Charlesbourg
		Lorette 7
		Loretteville
		Québec
		Saint-Félix-du-Cap-Rouge
		Sainte-Foy
		Sillery
		Vanier
Regina	CMA	Regina
Saint John	CMA	Saint John
Saskatoon	CMA	Saskatoon
Sherbrooke	CA	Sherbrooke
St. Jérôme	CA	Saint-Jérôme
St. John's	CMA	St. John's
Trois-Rivières	CMA	Trois-Rivières
		Trois-Rivières-Ouest
Vancouver	CMA	Barnston Island 3
		Burnaby
		Burrard Inlet 3
		Capilano 5
		Coquitlam
		Coquitlam 1
		Coquitlam 2
		Delta
		Greater Vancouver, Subd. A
		Lions Bay
		Mission 1
		Musqueam 2
		New Westminster
		North Vancouver
Winnipeg	CMA	Charleswood
		East Kildonan
		Fort Garry
		North Kildonan
		Old Kildonan
		St. Boniface
		St. James
		Transcona
		Tuxedo
		West Kildonan
		Winnipeg